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PERFORMANCE STUDIES ON DIESEL ENGINE STABILIZED WITH TBC AND GLYCINE MAX BLENDED OIL

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ABSTRACT

These days, thermal barrier coatings are gaining remarkable attention among researches owing to their wide applications and impact on several critical performance parameters of an engine. This throws light on the experimental investigation of a thermal barrier coated (TBC) piston crown in an engine imbibed with Glycine Max (Glycine Max) oil blended diesel engine. A comparative study was done on the engine with and without TBC. For this, Yittria Stabilized Zirconia was plasma sprayed as the TBC on the top of the engine piston, cylinder heads and even on the valves. Due to the presence of TBC it was observed that the heat transfer was minimized to a very high percentage. The blending ratio of the oil was varied from 10% -50% in order to study the critical performance variables and CO, HC, NO and CO2 emissions. By incorporating Yittria Stabilized Zirconia as a piston coating and fuel as soya bean oil the mechanical, brake thermal efficiency, indicated thermal efficiency and volumetric efficacies were enhanced remarkably and fuel consumption was drastically reduced.

KEYWORDS: Diesel, Glycine Max Oil, TBC, Yittria Stabilized Zirconia, Plasma Spray Technique & Emissions characteristics

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Original Article

INTRODUCTION

A vast group of research community, conducted experiments to reduce the emissions in diesel engine by blending with Glycine Maxoil (1-7). The different process of biodiesel preparation methods, engine performance was evaluated by varying the injection and the combustion timing in 20% blends and found that there was a steep reduction in CO, NOx emissions. The NOx emission in biodiesel can be decreased by employing the exhaust gas recirculation technique. An experimental study has proved that about 75% of turpentine oil as replacement with diesel in dual fuel mode, the emission and engine performance were improved. Performance and emissions were improved by blending diesel with the mixture of Jatropha oil, methanol and orange oil in different proportions A comparative study of the performance when fuel was used as Cashew nut shell oil, 30 % Camphor oil blend and diesel. Experiments proved that 100 % pine oil can be used in diesel engine which reduces CO, HC and smoke emissions and increases brake thermal efficiency.

The objective of this paper is to minimize the heat rejection through the engine parts by coating with thermal barrier coating when Glycine Max oil was blended in the diesel engine.

The primary purpose of the TBC is to raise surface temperatures during the expansion stroke, thereby decreasing the temperature difference between the wall and the gas to reduce heat transfer. Reducing heat transfer also increases exhaust gas temperatures, providing greater potential for energy recovery with a turbocharger.

Additional benefits include protection of metal combustion chamber components from thermal stresses and reduced cooling requirements. Thermal barrier coatings are most commonly stabilized Zirconia such as Yittria Stabilized Zirconia (YSZ), but other ceramics like Silicon Nitride (SN) have been used. Thermal conductivities (k) have ranged from less than 0.5 W/m K - 10 W/m K and thicknesses have ranged from 0.1 mm to 4.5 mm. Ceramic coatings can be applied by a variety of methods. Figure.1 shows the TBC consist of Top Coat and Bottom Coat.

Figure 1: Thermal Barrier Coating Consisting of Metallic Bond Coat on the Substrate and Ceramic Top Coat on the Bond Coat

These fuels have acknowledged because they significantly reduce exhaust emissions and the overall emissions of carbon dioxide (CO2) when they burnt as fuel. Glycine Max oil is a vegetable oil extracted from the seeds of the soya bean. It is one of the most generally consumed cooking oils. As a drying oil, processed Glycine Max oil is also used as a base for printing inks (soy ink) and oil paints. Present work aims at investigating critical performance parameters on aforementioned coating and oil to augment its effective applications.

EXPERIMENTAL SETUP

A four stroke diesel engine connected with electrical loading was used to estimate the performance analysis at different loading conditions and diesel blend with piston coating and without piston coating. The Table 1 pin points the specification of diesel engine taken for the experimentation.

Table 1: Diesel Engine Provisions Considered for this Study

Bore	80mm
Stroke	110mm
RPM	1500
BHP	5
Compression Ratio	16:1
Generator efficiency	80%

Figure 2: Four Stroke Single Cylinder Diesel Engine (Generator Loading)

Figure. 2 shows the experimental setup that consists of four stroke diesel engines connected with electrical loading. The performance and emission analysis were estimated at different loading conditions and different diesel blends with Glycine Max oil with piston coating and without piston coating.

PERFORMANCE OF DIESEL BLENDS WITHOUT PISTON COATING

Performance at Fuel Injection Pressure 180 Bar

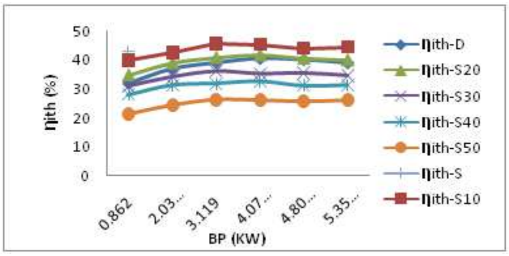

Figure 3: Graphical Representation of Brake Power vs η_{ith}

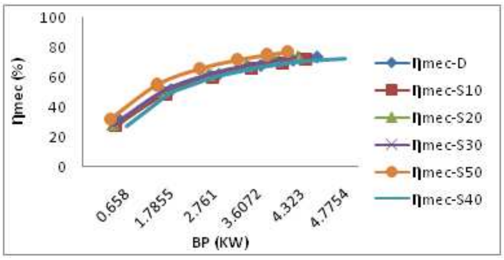

Figure 4: Graph Showing BP Vs η_{mec}

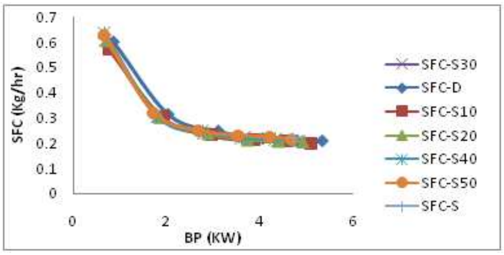

Figure 5: Graph Denotes Brake Power Vs SFC

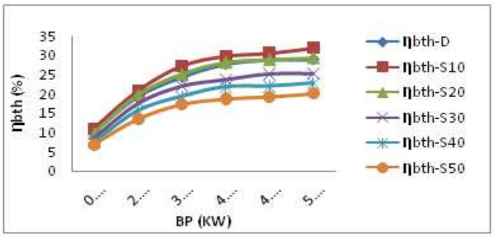

Figure 6: Graphical Representation of Brake Power Vs η_{bth}

Figures 3 and 4 embody the indicated thermal efficiency and mechanical efficiency with respect to the brake power when different blend ratios were used in the diesel engine when the injection pressure was 180 bars without any thermal barrier coating. The graph proves that as the blending ratio increases the mechanical efficiency increases, but the indicated thermal efficiency decreases for the increase in the brake power. Figures 3 and 4 point out the indicated thermal efficiency and mechanical efficiency with respect to the brake power when different blend ratios were used in the diesel engine when the injection pressure was 180 bar without any thermal barrier coating**.** The graph proves that as the blending ratio increases the mechanical efficiency increases, but the indicated thermal efficiency decreases for the increase in the brake power.

Performance at Fuel Injection Pressure 205 Bar

Figure. 5 depicts the specific fuel consumption for the particular brake power and it shows that there is no steep difference in specific fuel consumption for the blending difference. Figure. 6 shows the graphical representation of brake thermal efficiency for the brake power and it proves that at 10% blend gives the maximum value than the others. Figure. 7, 8 and 9 shows the graphical representations at injection pressure of 205 bar when the piston is not coated.

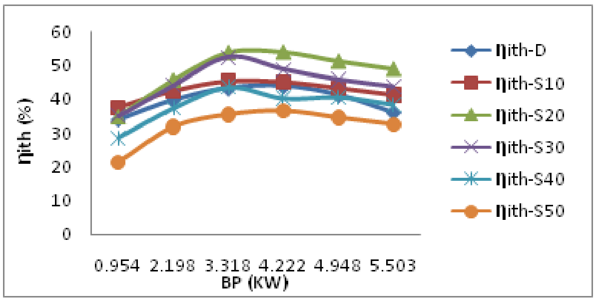

Figure 7: Graphical Representation of Brake Power Vs η_{ith}

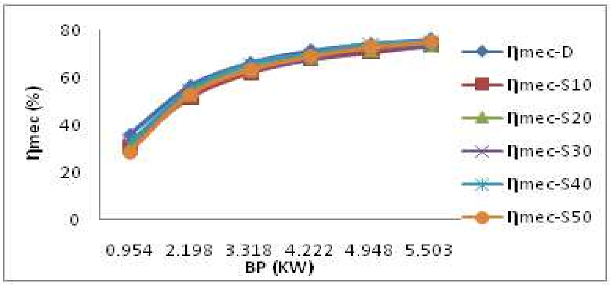

Figure 8: Graphical Representation of Brake Power Vs η_{mec}

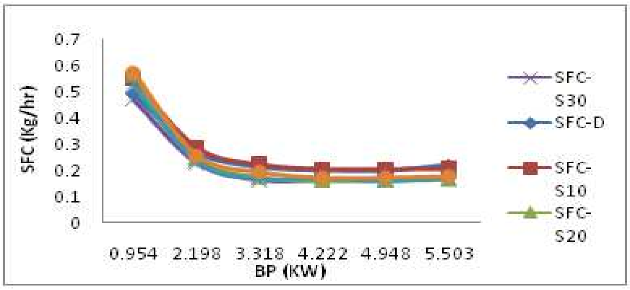

Figure 9: Graph Denotes Brake Power Vs SFC

PERFORMANCE OF DIESEL BLENDS WITH PISTON COATING

Performance at Fuel Injection Pressure 180 Bar

Figure. 10, 11 and 12 represents the graphical curve when the piston crown is coated and the injection pressure was maintained at 180 bars.

By using Yittria Stabilized Zirconia as piston coating and fuel as Glycine Max oil the efficiencies such as mechanical, brake thermal efficiency, indicated thermal efficiency and volumetric efficiency can be increased. Special fuel consumption reduces.

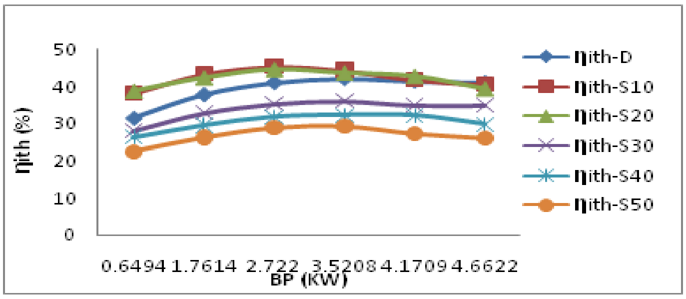

Figure 10: Graph Represents of Brake Power Vs η_{ith}

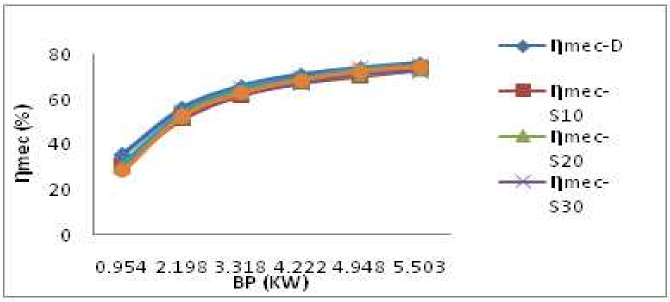

Figure 11: Graph Shows of Brake Power Vs η_{mec}

CONCLUSIONS

In conclusion, our work aimed at studying the influencing parameters of alternative fuels like soya bean oil on diesel engines due to their effective attributes. Many researchers have worked on piston crown coatings with varying proportions; however, very few have attempted on Soya bean oil. The following are the some of the noteworthy observations of this work:

- The indicated thermal efficiency at blend B10 with coating was effective when compared to B20, B30, B40, and B50 respectively.
- It was observed that mechanical efficiency for a coated piston with blend B10 has given a better performance.
- The specific fuel consumption for a coated piston with blend B10 was lower than the other blends.
- The brake thermal efficiency at all blends for coated piston is slightly higher than the uncoated one.
- It was observed that the uncoated piston gives better performance at 205 bar in comparison to 180 bar pressure.

Finally, it can be concluded that compared to an un-coated piston, a TBC coated piston's engine efficiency can be improved; further, fuel consumption can also be reduced.

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